BMC Neuroscience

BioMed Central

Poster presentation

Predicting synchrony and asynchrony in basket cell networks coupled by multiple dendritic gap junctions

Tariq Zahid[1] and Frances K Skinner*[1,2]

Address: [1]Toronto Western Research Institute, University Health Network, Toronto, Ontario, M5T 2S8 Canada and [2]Departments of Medicine (Neurology), Physiology and IBBME, University of Toronto, Toronto, Ontario, Canada

Email: Frances K Skinner* - fskinner@uhnres.utoronto.ca

* Corresponding author

from Seventeenth Annual Computational Neuroscience Meeting: CNS*2008
Portland, OR, USA. 19–24 July 2008

Published: 11 July 2008

BMC Neuroscience 2008, **9**(Suppl 1):P146 doi:10.1186/1471-2202-9-S1-P146

This abstract is available from: http://www.biomedcentral.com/1471-2202/9/S1/P146

Hippocampal inhibitory interneurons are not a homogenous group of cells, contributing to brain activities in particular and distinct ways. For example, axo-axonic and parvalbumin-positive (PV+) basket cells fire preferentially on the peak and descending phases of hippocampal theta oscillations [1].

Basket cells in hippocampus form mutually inhibitory networks and target perisomatic regions of the output pyramidal cell population. Furthermore, they are major players in producing gamma rhythms both *in vitro* and *in vivo* [e.g., [2,3]]. Network models incorporating experimentally derived synaptic characteristics produce robust and coherent gamma oscillations, thus suggesting that synchronous output from basket cell networks are important contributors to gamma rhythms. In addition to inhibitory synapses, PV+ basket cells are electrically coupled with gap junctions at multiple locations between their apical and basal dendrites, several hundred microns from their somata [4]. Given that direct electrical communication between neurons plays an important role in shaping network output, it is important to understand how non-proximally located gap junctions contribute to produce synchronous output in basket cell networks. In a previous study we built compartmental models of basket cells with active dendrites and showed that when gap junctions are located distally, there could be sensitive tuning of network dynamics with changes in gap junction conductances [5].

In the work here we built compartmental models of basket cells with different distributions of ion channels in basal and apical dendrites, and explored the dynamics of two-cell networks coupled at non-proximal locations. We first compared full (372 compartments) and reduced (3 compartments) compartmental models to define synchronous and asynchronous regimes. We then quantified phase response curve characteristics in terms of their skewness to predict the network dynamics (synchronous or asynchronous) of reduced models using weakly coupled oscillatory theory. We found that the predictions from quantified phase response curves also held reasonably well when the full compartmental models were coupled at basal or apical dendrites. We next built two-cell networks that were coupled at two and three locations, and computed the average of each of the phase response curves obtained for the different coupling sites. We found that the quantification applied to the averaged phase response curves correctly predicted the network output. This suggests that quantification of phase response curves can be used to predict the output of networks that are coupled with gap junctions at more than one location.

Acknowledgements

We thank NSERC for funding, and F. Saraga for help with the compartmental models.

References

1. Klausberger T, Magill PJ, Marton LF, Roberts JD, Cobden PM, Buzsáki G, Somogyi P: **Brain-state- and cell-type-specific firing of hippocampal interneurons *in vivo*.** *Nature* 2003, **421**:844-848.
2. Hajos N, Palhalmi J, Mann EO, Nemeth B, Paulsen O, Freund TF: **Spike timing of distinct types of GABAergic interneuron**

during hippocampal gamma oscillations *in vitro*. *J Neurosci* 2004, **24:**9127-9137.
3. Tukker JJ, Fuentealba P, Hartwich K, Somogyi P, Klausberger T: **Cell type-specific tuning of hippocampal interneuron firing during gamma oscillations *in vivo*.** *J Neurosci* 2007, **27:**8184-8189.
4. Fukuda T, Kosaka T: **Gap junctions linking the dendritic network of GABAergic interneurons in the hippocampus.** *J Neurosci* 2000, **20:**1519-1528.
5. Saraga F, Ng L, Skinner FK: **Distal gap junctions and active dendrites can tune network dynamics.** *J Neurophysiol* **95:**1669-1682.